Parafoil, Pallet Progress

X-38 developers use ingenuity to overcome challenge of parafoil 'reefing' in time to prepare for drop tests

By James Hartsfield

Developers of the X-38 prototype International Space Station crew return vehicle overcame one of the toughest challenges faced by the team so far with the recent successful pallet drop test of a stronger and more stable parafoil.

The project is now on track toward a drop test of the first unpiloted X-38 atmospheric test vehicle at the Dryden Flight Research Center in early February, said X-38 Project Manager John Muratore. The parafoil difficulties began for the X-38 team last summer as tests were under way on techniques for reefing the parafoil to increase its stability and uniformity during deployment. In a modification of a technique used in sport parachuting, the team was testing a system called "Zero-Stage Reefing" that holds the giant, rectangular X-38 parachute into a more round shape for a few seconds after its deployment, making it more stable.

To the team's surprise, during a pallet drop test of the new reefing system in October 1997 in Yuma, Ariz., the parafoil tore completely in half. The team went back to the drawing board to find a method of measuring and reducing stresses caused by the reefing and to strengthen the parafoil. But no system for measuring such forces in the cloth of a parachute existed.

Steve Fitzgerald of Engineering's Aeroscience Branch came to the rescue with a totally new method for instrumenting the leading edge of the parafoil and measuring the stresses it experienced. Fitzgerald worked with a Conroe company, Invocon Inc., that was developing tiny wireless data systems for NASA under a Phase III Small Business Innovation Research grant. Working with Fitzgerald, the company modified its systems to be used to measure forces in the parachute's canopy.

No such instrumentation had ever before been developed for a parachute, and the Invocon system now is expected to find widespread use outside of NASA within the parachute industry, Fitzgerald said.

"The people involved with parachute testing at the Army's Yuma Proving Ground are very interested, as well as others," Fitzgerald said. "This is the first time anyone has ever been able to do this, and that makes a lot of people involved in parachute testing excited."

The team spent the fall conducting a series of 20 subscale drop tests to measure forces on the parafoil and modifications to the reefing system "With Steve's instrumentation, we were able to determine where and how much the load was on the parafoil and to modify the reefing system to reduce it," Muratore said.

As a result of the measurements, the parafoil was strengthened as well. The parafoil's manufacturer, Pioneer Aerospace, modified the parachute at its Columbus, Miss., facilities, replacing the material in the bottom of the parafoil with a new material twice as strong as before.

The success of all of the modifications was borne out in the first full-scale pallet drop test of the new parafoil conducted Dec. 12 in Yuma. "It was a beautiful test, and everything worked perfectly," Muratore said. "The parafoil problems have definitely been the biggest challenge we have faced so far in the project. But to find out these things is why you do a lot of testing. You want to find out these problems when you have a less expensive pallet underneath the parachute instead of a full test vehicle."

Following the planned February test of the first X-38 atmospheric test vehicle, which was outfitted at JSC and shipped to the Dryden Flight Research Center last summer, unpiloted drop tests of three such vehicles will continue for the next two years. The first vehicle already has been through a series of captive carry flight tests, where it remained attached under the wing of the NASA B-52 aircraft at Dryden. For the February test, the vehicle will be dropped from an altitude of about 23,000 feet, flying free for only a few seconds before the parafoil is deployed.

The drop tests will work up to an altitude of about 50,000 feet and longer free-flight times for the X-38 vehicles prior to deployment of the parafoil. The second X-38 atmospheric test vehicle, which includes active flight control surfaces, already is being outfitted at JSC in Bldg. 220. It is scheduled to be shipped to Dryden in March and perform a drop test in May. The airframe for the third atmospheric vehicle is currently under construction in California. It also will be outfitted at JSC.

In addition, the parts for an X-38 space test vehicle already are being fabricated by Engineering's Manufacturing, Materials and Process Technology Division. The nose and forward part of the cabin for the X-38 space test vehicle, planned to fly an unpiloted space test from a space shuttle mission in 2000, already have been assembled in Bldg. 220. ❑

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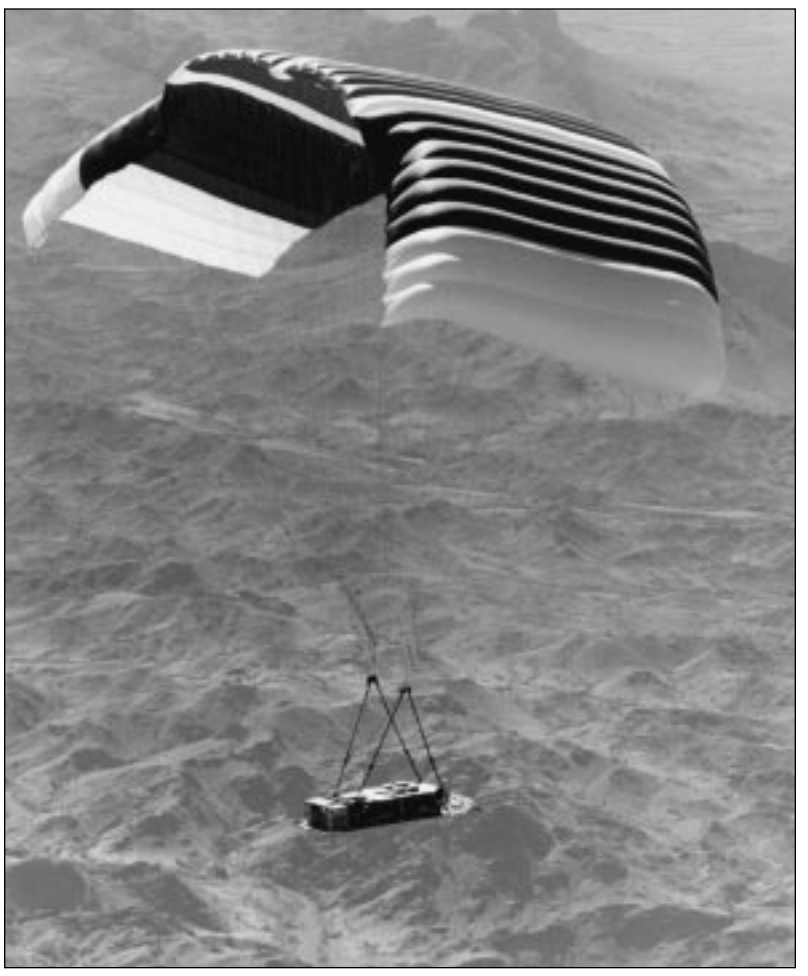

Photo Courtesy U.S. Army 97-C0505#36

Above: The first X-38 atmospheric test vehicle, outfitted at JSC and shipped to Dryden Flight Research Center last summer, has completed a series of "captive carry" flight tests where it remained attached under the wing of DFRC's B-52 aircraft. The vehicle is now being readied for its first drop test, targeted for early February. Left: Several months of subscale testing and redesigning paid off as a strengthened and more stable parafoil for the X-38 performed flawlessly in a full-scale pallet drop test at the Army's Yuma Proving Ground in early December 1997. The X-38 development team faced its toughest challenge so far when the parafoil tore in half during a similar drop test in October 1997. Below: Technicians at Dryden Flight Research Center receive the first X-38 advanced technology demonstrator on June 4. Bottom: A montage of photographs shows a 4-foot-long model of the X-38 gliding to Earth after a drop test from a Cessna aircraft.

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